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Sauaedafruticusa is hyperaccumulator of chromium and lead

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ABSTRACT

Suaedafruticosa shows a high growth rate in saline and contaminated soils. It grows in abiotic stresses with reducing the productivity of crops. Plant samples on a size basis (*40cm*, *60cm,* and *80cm*) were collected at different lagoons of KTWMA, Kasur. The plant samples were further distributed and characterized into different parts (roots, stem, leaf, and seeds) to check the availability of metals. The outcome indicated that chromium and lead concentration was higher in parts of the plant, especially in the stem. Chromium metal in the stem of different sized plants (small, medium, and large) was 42.2507±0.0352, 45.3528±0.0375, and 58.4065±0.1624.At the same time, lead concentration was found18.0125±0.0014, 26.3505±0.0034, and 27.8352±0.0038 that isless than chromium. Zinc concentration was observed least but noticeable during the experiment. Fromtheexperiment, it was concluded that *S. fruticosa* might act as a hyperaccumulator for different metals, especially Cr and Pb. Future studies are needed in order to mobilize and remove hazardous trace metals to keep the environment healthy.

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Introduction

Suaedafruticosa grows under highly saline conditions. Salinity stress is one of the main abiotic stresses in arid and semi-arid regions restricting crop production (Chekroun-Bechlaghem*et al*., 2019; Ksouri et *al*., 2012). Shah *et al*. (2020) suggested that *S. fruticosa*can be planted for re-establishment on arid-saline lands and cultivated as an unconventional edible or cash crop. Nearly 500 plant species have been known to hyperaccumulate heavy metals (Pollard *et al*. 2014). Hyperaccumulating plants can accumulate metals in parts of their roots and shoot from the contaminated soils. The qualities and systems of hyperaccumulation in the extraction of metals and furthermore distinguish the types of hyperaccumulation dependent on the plant's bioavailability of the metals.

Hyperaccumulation is also a trending technique to remove pollutants like heavy metals from aqueous media and contaminated soils. Hyperaccumulators are such plants that are able to grow at a high level of heavy metals, accumulating metals in their aerial parts, tissues, and roots. More than 500 plant species are considered hyperaccumulators and accumulate metals at different plant tissue levels. Most metals, whose biological functions are unknown, also get accumulated in various tissues (Ruk *et al*., 2006).

Hyperaccumulators are distinguished due to three specific hallmarks: heavy metal absorption with increased rate, earlier root-to-shoot transfer, translocation and improved ability to detoxify, accumulate heavy metals in leaves. Variety of plants belonging to distantly associated families except sharing the capacity to grow on metallic-ferous soils and to accumulate extremely huge concentrations of metals in aerial parts, way above the thresholds present in most animals, without phytotoxic impact, has been observed. A comparatively small community of hyperaccumulator plants is able to sequester metals present in higher concentrations in their root-shoot tissues. According to Yang *et al*. (2005), significant scientific advancements carried out to evaluate biochemical processes of metals uptake and translocation in plants in recent years. The process involved in hyperaccumulation by hyperaccumulators of metals from soil to shoots consist of a) bio-activation of metals rhizosphere by root-microbes interactions (b) improved uptake in plasma-membrane by transporters of metals (c) detoxification of metals by distributing to apoplasts such as binding with cell walls and chelation of metals in cytoplastic-membranes.

In recent decades, Sheoran et al. (2016) identified the metals accumulation in special environmental locations that have drawn significant public attention. Traditional cleanup methods for extracting and extracting heavy metals from mining sites are either inadequate or very expensive for developing countries. Research efforts have turned to phytochemistry in recent decades, using hyperaccumulators as an alternative and inexpensive source for heavy metal extraction. Elimination of metals is necessary to overcome global problems. These are removed by a variety of methods from the aqueous solutions by actions of bacterial species, fungus cultures, algae masses, mosses, macrophytes, and microphytes (Holan *et al*. 1994; Leusch *et al*. 1995; Knauer *et al*. 1997). Heavy metals are considered one of the leading pollutants from the last decade due to their environmental impacts, caused by natural and human activities resulting in health risks. They are referred to as ecosystem contaminants because of their transmission through dust particles, leaching in the course of soil, and by spreading solid waste material (sludge, tannery wastes).

The latest heavy metal remediation strategy from polluted soil-water is costly and time-consuming, and ecologically harmful. Metals do not decay, as opposed to organic compounds, and efficient cleanup, therefore, includes their immobilization to decrease toxicity. Throughout recent years, Scientists and engineers have begun to develop cost-effective innovations, including the use of In order to clean contaminated environments, microorganisms/biomass, or live plants. As heavy metals cause such deadly effects on human health, they should be treated or removed in a defined way. Many ways can remove these metals. Bio-absorbents are most effective in such away. Bacterial absorption is also effective for heavy metals removal for aqueous solution. Moreover, phytoremediation for combating heavy metals was also introduced worldwide.

Chromium is composed of usually found on earth surface such as Chromium (III) and Chromium (VI), characterized by distinct chemical properties, which are toxicities and a tough oxidizing agent and a strong oxidizing agent, Chromium (VI), While Chromium (III) is micro-nutrient and is extremely toxic, that is 10-100 times not as much of contaminated than a non-hazardous on Chromium (VI). It was recorded that Cr (VI) induced changes in the composition of microbial species in the soil and documented to have an adverse effect on microbial cells at high concentrations and metabolism. Lead (Pb) toxicity causes a decrease in hemoglobin synthesis, interferes in the functions of the kidney, cardiovascular systems, joints, reproductive systems, and chronic damage to the central and peripheral nervous systems (Ogwuegbu *et al*. 2005).

Wastewater concentration has been increased by increasing industrialization, overpopulation, agricultural practices, and economic conditions. Wastewater irrigation is a major cause of field soil contamination, causing an increase in heavy metals concentration (Pandey 2006). Generally, wastewater also includes a fair amount of beneficial nutrients and heavy metals for agricultural fields. Excessive use of wastewater for irrigation causes metals accumulation in agricultural soil (Mahmood *et al*. 2014). Fields irrigated with wastewater causes contamination is because of accumulations of metals on earth and ground-water. Since these foods are essential components of human diets, heavy metals pollution in vegetables should not be ignored. Vegetables, which also have positive antioxidant effects, are rich sources of vitamins, minerals, and fibers. However, there could be a danger to human health from the consumption of heavy metal-contaminated vegetables. The more important facts of food value assurance are heavy metal contaminations of foodstuff products.

Sampling site

KTWMA (N 31.09970^0, E 74.46209^0) is located in district Kasur. *S. Fruticusa* samples was collected from the sampling site, which is shown in figure 2.1.

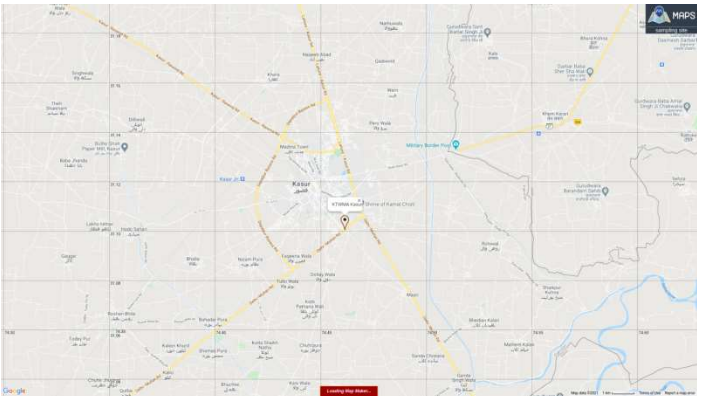


Figure 2.1: Sampling site KTWMA in Kasur

Sampling

Plant sampling

S.Fruticusa samples were collected from different outlet lagoons of KTWMA into polythene bags. Plant samples with different sizes (small, medium, and large) were collected for the study.

Plant parts Distribution

Collected plants were distributed into root, stem, leaf, and seeds to check the availability of different metals in different parts of the plant.

Samples Preparation

Samples of plant parts (root, stem, and leaf) were washed with distilled water for removal of soil and other debris, oven-dried, crushed with mortle and pestle, and then sieved through 2mm sieve. The seeds were collected, oven-dried and then crushed in fine powdered form with the help of mortle and pestle.

Samples digestion

5g of each sample was digested into HCLO4 and HNO3 (10ml) with 3:1 at 85C0 for 15-20 minutes on a hot plate until the color of the solution became transparent. Solutions were filtered with Whatman filter paper, cooled at room temperature, and filtrate kept in a beaker for metal analysis. Then the volume of the solution increased to 50ml by adding distilled water.

Sample analysis

The samples were analyzed by using AAS (atomic absorption spectrophotometer) for evaluating the concentration of metals in each sample.

Statistical analysis

Result

Metals accumulation in plant parts

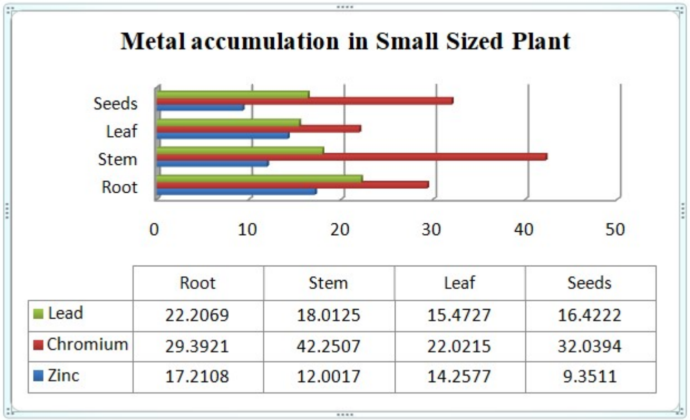
Table 3.1 Metals concentrations of S.Fruticusain different parts were calculated, shown in table 3.1.

Table 3.1: Metals concentrations in different parts of *S.Fruticusa*:

Plants Type (Size Based)	Metals	Plant Parts			
		Root	Stem	Leaf	Seeds
Small (40*cm*)	Zinc	17.2108±0.0041	12.0017±0.0081	14.2577±0.0261	9.3511±0.0071
	Chromium	29.3921±0.0452	42.2507±0.0352	22.0215±0.0281	32.0394±0.0150
	Lead	22.2069±0.0038	18.0125±0.0014	15.4727±0.0028	16.4222±0.0175
Medium (*60cm*)	Zinc	19.4703±0.0052	14.5624±0.0085	15.0545±0.0294	11.4018±0.0092
	Chromium	35.5367±0.0054	45.3528±0.0375	27.1245±0.0375	36.5204±0.0205
	Lead	23.0905±0.0483	26.3505±0.0034	16.5204±0.0025	19.0745±0.0175
Large (*80cm*)	Zinc	19.9703±0.0058	16.0432±0.0095	18.0502±0.0085	14.5216±0.0055
	Chromium	44.0512±0.0105	58.4065±0.1624	29.0253±0.0295	40.1284±0.0255
	Lead	26.1547±0.0362	27.8352±0.0038	12.4398±0.0030	23.1449±0.0308

Metal accumulation in small-sized plant

Small-sized plants accumulated different metals with a different ratio. Figure 3.1 showed the level of metals accumulation in different parts of *S.Fruticusa*. The accumulation of metals Lead (Pb), Chromium (Cr), and Zinc (Zn) were found more in the stem part of the plant. Within these metals, Chromium concentration was found higher in different parts than other metals.

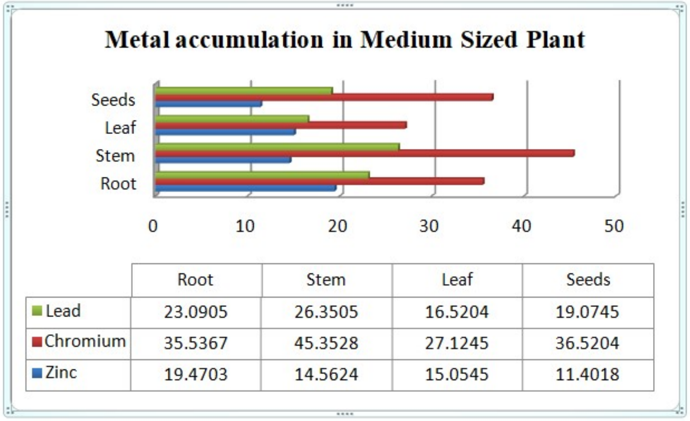


	Root	Stem	Leaf	Seeds
🟩 Lead	22.2069	18.0125	15.4727	16.4222
🟥 Chromium	29.3921	42.2507	22.0215	32.0394
🟦 Zinc	17.2108	12.0017	14.2577	9.3511

Figure 3.1: Metals concentrations in parts of small-sized plants.

Metal accumulation in medium-sized plant

Medium-sized plants accumulated different metals with a different ratio. Figure 3.2 showed the level of metals accumulation in different parts of *S.Fruticusa*. The accumulation of metals Lead (Pb), Chromium (Cr), and Zinc (Zn) were found slightly more in the medium-sized plant as compared to small-sized plants. Chromium metal was found higher in the stem part.

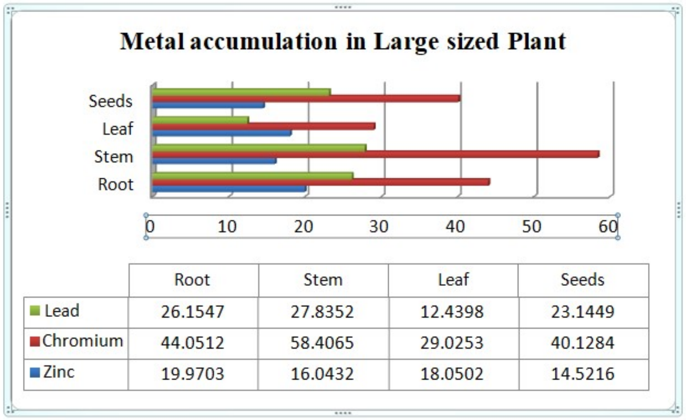


	Root	Stem	Leaf	Seeds
🟩 Lead	23.0905	26.3505	16.5204	19.0745
🟥 Chromium	35.5367	45.3528	27.1245	36.5204
🟦 Zinc	19.4703	14.5624	15.0545	11.4018

Figure 3.2: Metals concentrations in parts of medium-sized plants.

Metal accumulation in large-sized plant

Large-sized plants accumulated different metals at higher concentrations with a different ratio. Figure 3.3 showed the level of metals accumulation in different parts of *S.Fruticusa*. The accumulation of metals Lead (Pb), Chromium (Cr), and Zinc (Zn) were found maximum in the large-sized plant as compared to small and medium-sized plants. All metals were highly accumulated in the stem as compared to other parts of plants.



	Root	Stem	Leaf	Seeds
🟩 Lead	26.1547	27.8352	12.4398	23.1449
🟥 Chromium	44.0512	58.4065	29.0253	40.1284
🟦 Zinc	19.9703	16.0432	18.0502	14.5216

Figure 3.3: Metals concentrations in parts of large-sized plants Discussion.

This should explore the significance of the results of the work.

District Kasur is an industrial area near Lahore. Industries release wastewater having a fair amount of heavy metals into the environment. These metals cause negative and hazardous impacts on livings. Small-sized plants, including their parts, showed the accumulation of metals. Liu *et al*. (2019) identified cadmium accumulation by the *Lantana Camara*plant. Differenthyperaccumulating plants show different specific metal accumulation results (Amjad*et al*., 2019). Almost similar results were observed during the experiment. As the size of the *S. Fruticusa* plant increased, metals accumulation in different parts increased. In small-sized plant (*40cm*), zinc metal concentration was 17.2108±0.0041, 12.0017±0.0081, 14.2577±0.0261, and 9.3511±0.0071 inthe root, stem, leaf,and seeds, respectively. In medium-sized plant (*60cm*), zinc metal concentration was 19.4703±0.0052, 14.5624±0.0085, 15.0545±0.0294, and 11.4018±0.0092 in root, stem, leaf, and seeds, respectively. While in the large-sized plant (*80cm*), zinc metal concentration was19.9703±0.0058, 16.0432±0.0095, 18.0502±0.0085 and14.5216±0.0055 in root, stem, leaf, and seeds, respectively.

In small-sized plant (*40cm*), chromium metal concentration was 29.3921±0.0452, 42.2507±0.0352, 22.0215±0.0281, and 32.0394±0.0150 inroot, stem, leaf, and seeds, respectively. In medium-sized plant (*60cm*), chromium metal concentration was 35.5367±0.0054, 45.3528±0.0375, 27.1245±0.0375, and 36.5204±0.0205in root, stem, leaf, and seeds, respectively. While in the large-sized plant (*80cm*), chromium metal was 44.0512±0.0105, 58.4065±0.1624, 29.0253±0.0295, and 40.1284±0.0255in the root, stem, leaf, and seeds, respectively.

In small-sized plant (*40cm*), lead metal concentration was 22.2069±0.003818.0125±0.0014, 15.4727±0.0028 and 16.4222±0.0175inthe root, stem, leaf, and seeds, respectively. In medium-sized plant (*60cm*), lead metal concentration was 23.0905±0.0483, 26.3505±0.0034, 16.5204±0.0025, and 19.0745±0.0175in root, stem, leaf, and seeds, respectively. While in the large-sized plant (*80cm*), lead metal was 26.1547±0.0362, 27.8352±0.0038, 12.4398±0.0030, and 23.1449±0.0308in the root, stem, leaf, and seeds, respectively.

Accumulation of chromium was found higher in all parts of the plants in each size. Lead concentration was slightly lower than chromium. Zinc metal was found in the least amount as compared to other observed metals. Hyperaccumulation and removal of these metals areamongthe major concerns in developing countries in the last decades. The result indicated that *S.Fruticusa*could be used as a hyperaccumulator. It can be usedfor the removal of metals.

Conclusion

*S.Fruticusa*accumulates metals in different parts of the body. It can be used as a hyperaccumulator though it is observed during the experiment. It is concluded that Cr and Pb can be phytochemically removed by *S.Fruticusa.*Further work to remove hazardous trace metals from water and soil should be carried out to keep the environment healthy

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Conflicts of interest

We declare that there is no conflict of interest**.**

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Supplementary Material

Supplementary material, if any, that may be helpful in the The data that support the findings of this study are openly available on request.